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Soil Survey
of
Grant County, Oklahoma

By

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United States Department of Agriculture, in Charge

and

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Oklahoma Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the
Oklahoma Agricultural Experiment Station

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SOIL SURVEY OF GRANT COUNTY, OKLAHOMA

By A. W. GOKE, United States Department of Agriculture, in Charge, and C. A. HOLLOPETER and M. E. CARR, Oklahoma Agricultural Experiment Station

COUNTY SURVEYED

Grant County is in the north-central part of Oklahoma. Its northern boundary is formed by the Kansas-Oklahoma State line (fig. 1). Its latitude is approximately that of Norfolk, Va., and northern Arizona, and its longitude is about that of Fargo, N. Dak., and Fort Worth, Tex. The county is almost square in outline. Its greatest dimension is from east to west, 36 miles, and its width from north to south is 28 miles. The total area is 994 square miles, or 636,160 acres.

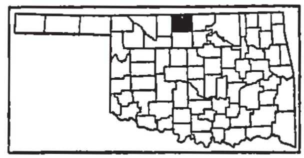

FIGURE 1.—Sketch map showing location of Grant County, Okla.

This county lies in the plains region of Oklahoma, which slopes slightly toward the east. The land, in general, is smooth, consisting of small areas of undissected upland scattered throughout a region of slight but rather thorough dissection. The level areas occur in those parts of the county where the original plain has not been encroached on by drainageways. The largest of such areas lies northeast of Numa. Most of the sloping areas are smooth, and they gradually descend to the valley bottoms. Steep and badly eroded areas (badland characteristics) prevail in only a few places and embrace a very small percentage of the total area of the county.

The most pronounced surface relief has been produced through stream erosion by Salt Fork Arkansas River across the southern part. This river has produced a shallow lowland belt that varies in width in its course across the county. The widest part is in the eastern part and the narrowest in the western. In many places the sandy material in the valley has been heaped into high dunes, whereas the heavier soil materials have flat or undulating surface relief, rising only a few feet above the river bed.

The river channel of Salt Fork Arkansas River pursues a winding course down the valley. Its bed is only a few feet below the general surface level of the valley and about one-fourth of a mile wide. During most of the year a narrow and shallow stream threads its way down the river bed. In some places it subdivides into numerous braided channels which unite farther down the river. After each submergence of the river bed the stream has its course shifted from one side of the river channel to the other. The river bed consists of loose sand and gravel, free of vegetation, and it is often covered with water when the river is congested with an unusual amount of water.

Most of the county is drained by Salt Fork Arkansas River and its tributaries, the more important of which are Pond Creek, Sand Creek, Crooked Creek, Osage Creek, and Cottonwood Creek. Bluff Creek and Deer Creek are the two important streams that drain the

northeastern corner. All these streams are bordered by alluvial lands that are admirably adapted to the use of farm machinery, especially the terraces that range from 1 mile to 1¼ miles in width. The largest bodies of alluvial land are along Salt Fork Arkansas River. The flood plains in most places are narrow and are adapted to cultivation in only a few places. They are subject to overflow, and, as the surface material is predominantly sandy, it is subject to wind action.

The range of elevation throughout the county is slight. The altitude above sea level at a point along the Atchison, Topeka & Santa Fe Railway, 2 miles east of Numa, is 1,108 feet, and at Jefferson it is 1,062 feet.

Grant County was formerly a part of the Cherokee Strip, a tract about 55 miles wide extending from eastern Oklahoma to the western part of the State. This strip was set aside for the use of the Indians, but later, after the county was organized in 1890, it was opened for settlement by white people.

The population, according to the 1930 census, is 14,150, of which 97 percent is native white, 0.1 percent Negro, and 2.5 percent foreign-born white. Of the total population, 9,703 people are classed as rural farm and 4,447 people are classed as rural nonfarm. In the rural districts the population is fairly evenly distributed. In most parts of the county there are two or three farm homes on each square-mile section of land, but a few sections in the most sandy or badly eroded parts are uninhabited.

Towns and railway stations are in sufficient number and of such convenient location that all farm communities are conveniently served. The largest towns are Medford, the county seat, Pondcreek, Lamont, Nash, Jefferson, Wakita, and Manchester. Saltfork, Numa, Renfrow, and Gibbon are smaller towns. All these towns are connected by railroads and county roads.

Transportation facilities are good, and no place is more than 12 miles from a shipping point. Most of the county roads are of dirt construction and are kept in good repair. They extend along section lines to all parts of the county. Wichita, Kans., lying about 80 miles north of Medford, is a good market for farm products and is easily reached by paved road. A paved highway extends north and south through the county, connecting the towns of Pondcreek, Jefferson, Medford, and Renfrow.

School facilities are good. In the rural sections, schools are established at convenient intervals and are equipped to give class instructions for the first eight grades of school work. After the pupil has finished the required work in the rural schools, he is transferred to a nearby high school in one of the towns. Most of the high schools have an instructor who devotes all his time to agricultural subjects and vocational work in the nearby communities.

Most of the farm homes have telephone service and rural delivery of mail.

Water used for drinking purposes has a high content of gypsum and sodium salts, which give it a very disagreeable taste and also have a bad effect on the health of people not accustomed to it. Water obtained in the sandy sections is of better quality than that obtained in the sections of heavier soil. Therefore, towns along Salt Fork Arkansas River, where the land is sandy, are favored with a good quality of water. The supply of water for Medford is piped in from

a well located in the sandy area southwest of Jefferson. A few farm homes are supplied with water from cisterns.

CLIMATE

According to records of the United States Weather Bureau station at Jefferson, Grant County has a mean annual precipitation of 29.52 inches, which is about 6 inches less than the amount recorded at Newkirk, situated about 45 miles east of Jefferson, in Kay County. Most of the rainfall occurs during the period from April to October, inclusive. Some winters are extremely dry, with only 3 or 4 inches of precipitation. The spring rains are usually sufficient to produce good crops of small grain, but corn, alfalfa, and kafir very frequently suffer severely from lack of moisture in late summer. Snow seldom falls, and it remains on the ground only a short time. Thunderstorms and hailstorms occur occasionally. Tornadoes are infrequent, although sometimes the wind reaches a high velocity.

The average annual temperature at Jefferson is 58.3° F. The winters, as a rule, are short and mild, but an extreme temperature of −23° has been reported. The summers are long and hot. Temperatures of 100° or more have been recorded in May, June, July, August, September, and October. Frequently hot winds occur during the summer and do much damage to corn and other crops.

The average length of the frost-free season, from April 9 to October 25, is 199 days, but frost has been known to occur as early as September 25 and as late as May 1.

Table 1 gives the more important data regarding climatic conditions, as recorded at the Jefferson station of the Weather Bureau.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Jefferson, Grant County, Okla.*

[Elevation, 1,062 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1908)	Snow, average depth
	°F.	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	36.7	75	−4	1.07	0.30	0.04	1.2
January	33.7	85	−16	.92	2.68	1.02	.8
February	37.0	90	−23	1.09	.38	2.40	2.3
Winter	35.8	90	−23	3.08	3.36	3.46	4.3
March	48.1	97	2	1.61	.00	3.25	1.0
April	57.8	96	17	2.91	2.06	3.38	(1)
May	66.8	104	25	4.05	2.55	11.55	.0
Spring	57.6	104	2	8.57	4.61	18.18	1.0
June	76.6	110	42	4.26	1.29	5.74	.0
July	81.4	113	50	2.80	.39	2.86	.0
August	81.1	112	40	3.28	3.45	4.08	.0
Summer	79.7	113	40	10.34	5.13	12.68	.0
September	73.4	106	31	3.28	.52	12.19	.0
October	60.4	102	11	2.71	.08	3.86	.1
November	46.9	85	6	1.54	.00	4.52	.6
Fall	60.2	106	6	7.53	.60	20.57	.7
Year	58.3	113	−23	29.52	13.70	54.89	6.0

[1] Trace.

AGRICULTURE

Cattle raising was the chief occupation of the early settlers before the land was opened for homestead entry by the Government. These early occupants rented large tracts of land from the Indians and owned large herds of livestock, mainly cattle, but they were forced to abandon the land when it was bought from the Indians and officially opened for settlement in 1893.

During the first few years of occupation under the Government, feed crops were the principal crops grown, corn occupying the largest acreage. According to the census for 1930, wheat ranks first among the grain crops in acreage, corn second, and oats third.

Table 2 gives the acreage and production of the principal crops grown in Grant County in 1899, 1909, 1919, and 1929.

TABLE 2.—*Acreage and production of the principal crops grown in Grant County, Okla., in stated years*

Crop	1899		1909		1919		1929	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Wheat	135, 924	1, 805, 240	129, 947	1, 617, 184	287, 770	4, 387, 050	333, 378	2, 820, 435
Corn	89, 572	2, 523, 590	147, 955	2, 781, 813	17, 352	202, 529	35, 626	585, 436
Oats	8, 941	330, 270	34, 172	1, 141, 109	25, 289	648, 859	19, 692	542, 139
Kafir and milo maize	7, 526	110, 528	6, 941	100, 723	8, 085	71, 417	[1] 6, 424	[1] 71, 746
Potatoes	431	28, 112	542	34, 180	322	21, 685	289	26, 877
Sweetpotatoes	115	8, 791	49	4, 993	35	2, 348	49	6, 805
		Tons		*Tons*		*Tons*		*Tons*
Prairie hay	30, 268	31, 668	14, 474	14, 233	5, 775	4, 789	3, 465	3, 308
Alfalfa	1, 045	2, 121	14, 788	31, 578	27, 303	46, 537	10, 054	22, 868
	Trees	*Bushels*	*Trees*	*Bushels*	*Trees*	*Bushels*	*Trees*	*Bushels*
Apples	95, 296	----------	88, 055	1, 063	21, 504	19, 461	5, 351	4, 449
Peaches	519, 280	247	173, 378	104	19, 014	6, 270	7, 222	3, 642
	Vines	*Pounds*	*Vines*	*Pounds*	*Vines*	*Pounds*	*Vines*	*Pounds*
Grapes	195, 062	79, 300	111, 546	49, 846	4, 304	12, 145	3, 980	12, 239

[1] Chiefly kafir.

The average yield of wheat, depending on the type of soil on which the crop is grown, ranges from 5 to 30 bushels. The chief varieties are Kanred and Turkey. Corn returns an average yield between 5 and 10 bushels an acre on the uplands, whereas on the bottomlands acre yields are as high as 40 bushels. On many of the heavy soil types in the uplands corn in most seasons fails to mature properly and dries up before the end of the season. On such land the crop should be grown mainly for fodder. Oats are grown mostly for use as feed on the farm. They are usually planted as early as possible in the spring on land used the preceding year for corn.

During late years some attempt has been made to introduce the growing of cotton, especially in the sandy sections. The census of 1930 shows that 100 bales of cotton were produced on 282 acres of land in 1929.

Several farmers having land on the terraces along Salt Fork Arkansas River grow watermelons and cantaloups to be sold in the local and distant markets. Where the melons are extensively grown, around Lamont and Pondcreek, a cooperative association of melon growers has been formed for the purpose of obtaining a suitable market for these products. Each year several carloads of melons are shipped from Pondcreek and Lamont to distant markets.

The principal kinds of domestic livestock kept on the farms are horses, mules, cattle, chickens, swine, and small flocks of sheep and goats. Horses and mules are used mainly for draft purposes. Their

number has steadily declined since 1910, owing in part to the increasing use of tractors. The 1920 census shows 19,757 horses, and in 1930 there are 9,567 horses. The number of mules decreased from 4,903 in 1920 to 2,296 in 1930.

The cattle on most of the farms are of the dairy type, principally of the Jersey breed. Jerseys are preferred above any other breed because it is said that the food requirement of these cows, in order to sustain a normal flow of milk, is less than for cows of any other breed. Since feed for milk cows on many of the farms is very short during certain parts of the summer season, it is important that cows of a breed that require a small quantity of roughage should be selected.

A large part of the winter feed for the livestock is obtained through pasturing the wheat fields. If favorable moisture conditions prevail during the fall so that wheat has developed a good growth, a large quantity of feed is available.

A few beef cattle are raised on farms that include a large acreage of native grasses. The beef cattle are principally of the Hereford and Shorthorn breeds. According to the 1930 census, there were 34,733 cattle in the county on April 1 of that year. Only a few farmers specialize in swine, which are raised chiefly on the valley lands where corn and alfalfa can be easily grown. The number of hogs on the farms in 1930 was 21,423. Poland China and Duroc-Jersey are the most popular breeds.

Chickens are raised on almost every farm, and in a few sections poultry raising has developed into a specialized industry with considerable attention given to selection and breeding. The most popular breeds of chickens are Buff Leghorn, Buff Orpington, Langshan, Buff Minorca, White Leghorn, Plymouth Rock, and Wyandotte. The 1930 census reports that 562,765 chickens were raised in Grant County in 1929.

Sheep are raised by only a few farmers. There were 21,603 sheep on the farms on April 1, 1930.

The number and size of farms has increased only slightly since 1920. The average value of land and buildings a farm was $14,093 in 1930 and the average acre value was $58.16. The greatest increase in the number of large farms has been among those including 500 or more acres. The number of farms with an acreage ranging from 500 to 999 acres has increased from 99 in 1920 to 162 in 1930. The number of farms of 1,000 or more acres increased from 4 in 1920 to 16 in 1930.

The 1930 census gives the total acreage of the different classes of land as follows:

	Acres
Crop land, total	458, 249
Crop land harvested	435, 875
Crop failure	14, 374
Idle or fallow land	8, 000
Pasture land, total	186, 805
Plowable pasture	67, 080
Woodland pasture	4, 822
Other pasture	114, 903
Woodland, not pastured	1, 300
All other land in farms	21, 754

The census for 1930 shows that 51.3 percent of the farms are operated by owners, 48.5 percent by tenants, and 0.2 percent by managers. The tenant farms are leased for a period ranging from 1 to 5 years, and they are rented either for cash or for a share of the crops grown. Cash rent is commonly paid for the use of pasture land and meadow.

The farm buildings on the average-sized farm are kept in good repair. They consist of a residence for the family, a well house, a barn for the horses and cattle, a chicken house, a granary for storage of grain, and a few small buildings for storing special equipment. Of the total capital invested on the average-sized farm, 75.1 percent is for land, 10.8 percent for buildings, 8.1 percent for implements, and 6 percent for domestic animals. The land is valued at about $50 an acre.

Most farms are equipped with implements, such as plows, harrows, cultivators, wagons, mowing machines, and hayrakes, that are used for minor farming operations. A tractor is a popular machine on almost every farm, and many farmers own a combine. In some communities where the farmers have small acreages in grain a combine is owned jointly by several farmers. Grain is usually stored in wooden or steel bins.

With the use of tractors, combines, and other modern kinds of machinery, the demand for an extra supply of labor during the harvest season is not so great as formerly, when many men were needed to aid in harvesting and threshing wheat. Every succeeding year it is becoming more difficult for transient labor to obtain employment in the harvest fields. Practically all the laborers are whites.

The largest item of expense incurred on the farms is for feed. In 1929, 1,623 farms reported an average expense for feed amounting to $192.08 a farm, which is 51 percent of the total expenses. On 1,639 farms a total of $289,202 was spent for labor, an average of $176.45 a farm reporting. Only 12 farms reported the use of fertilizers, at a total cost of $376, or $31.33 a farm.

The total value of farm crops has steadily increased since the organization of the county.

Table 3 gives the value of crops and livestock products produced in 1929 and the value of domestic animals on April 1, 1930.

TABLE 3.—*Value of agricultural products in Grant County, Okla., in 1929, and of domestic animals in 1930*

Crops	Value	Livestock and products	Value
Cereals	$3,550,129	Domestic animals	$2,518,899
Other grains and seeds	34,092	Dairy products, excluding home use	383,689
Hay and forage	489,730	Poultry and eggs	841,018
Vegetables (including potatoes and sweetpotatoes)	93,203	Wool	24,100
Fruits and nuts	26,949	Total	3,767,796
All other field crops	9,646		
Garden vegetables (for home use)	56,494	Total agricultural products	8,028,039
Total	4,260,243		

The kinds of crops predominately grown do not readily produce a diversified type of agriculture. The acreage devoted to wheat far exceeds that of any other crop. Wheat is disposed of on the local market as a cash crop and constitutes the chief source of farm income derived from crops. Wherever wheat is the major crop, other crops, such as oats, alfalfa, kafir, and corn, are grown on acreages large enough to provide feed for a few livestock that must necessarily be kept.

A diversified type of agriculture, in which the raising and feeding of livestock furnishes an important outlet for the crops produced, is prevalent only in certain sections where corn, alfalfa, and some minor crops can be successfully grown, especially wherever sandy soils with friable subsoils predominate. On these soils are located most of the farms on which the acreage is equally divided among wheat, corn, oats, alfalfa, and kafir. Wheat serves as a cash crop to provide part of the farm income, and the other crops are grown to provide feed for the livestock that are later sold on the local market to furnish additional income.

Livestock fed on the farms includes cattle and swine, but the swine are more extensively raised and fed on the alluvial lands along Salt Fork Arkansas River, where corn can be grown successfully. Hogs require corn for feed in order to make profitable gains, but cattle are raised wherever the farm contains plenty of pasture land or land that cannot be cultivated on account of rough relief or very sandy soil. Wherever the farms have some native pasture and land capable of producing good crops of corn and alfalfa, livestock of a special breed is raised, either Poland China or Duroc-Jersey hogs, or Hereford or Shorthorn cattle.

SOILS AND CROPS

The soils on which the crops of Grant County are produced are included in two groups, the silty soils and the sandy soils. All other soils are classed as untillable land. The sandy soils are composed of material that ranges from loamy sand to silt loam in the surface soil and is friable in the subsurface layers. The silty soils, on the other hand, have finer grained surface soil material that ranges from silt loam to silty clay loam, and they are friable only in the surface soil. A claypan layer is generally present in the subsoil of the silty soils at a depth of about 15 inches. The sandy soils occupy a large area bordering the western edge of the county, and they also occupy a large part of the valley of Salt Fork Arkansas River. The silty soils, together with the untillable lands, embrace the rest of the county.

In the following pages, the soils of Grant County are described, and their agricultural importance is discussed; their location is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of soils mapped in Grant County, Okla.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Oswego silt loam	125,248	19.6	Grant silt loam	21,120	3.3
Oswego silt loam, deep phase	18,560	2.9	Grant loamy very fine sand	256	.1
Renfrow silt loam	101,440	15.9	Reinach very fine sandy loam	49,600	7.8
Renfrow loam	2,432	.4	Reinach silt loam	27,328	4.3
Renfrow clay loam	20,480	3.2	Yahola loamy sand	128	.1
Kay silty clay loam	9,280	1.4	Yahola very fine sandy loam	8,256	1.3
Kay silt loam	28,352	4.4	Yahola silt loam	1,664	.3
Kay silt loam, alkali phase	1,024	.2	Osage silt loam	6,272	1.0
Pond Creek silt loam	10,304	1.6	Vernon clay loam, eroded phase	52,224	8.2
Miller clay loam	6,272	1.0	Grant very fine sandy loam, eroded phase	4,800	.8
Derby loamy sand	32,192	5.1	Derby sand	24,384	3.8
Derby fine sandy loam	19,456	3.1	Derby loamy sand, shallow phase	4,544	.7
Derby fine sandy loam, reddish-brown phase	18,432	2.9			
Grant very fine sandy loam	28,096	4.4	Total	636,160	
Grant very fine sandy loam, shallow phase	14,016	2.2			

SILTY SOILS

Wheat is the principal crop on the silty soils, whereas oats, corn, kafir, and alfalfa are of minor importance and are grown on very small acreages. Most farmers dwelling on land with silty soils report an average of 100 acres in wheat, 20 acres in corn, 20 acres in oats, and 5 acres in alfalfa.

Wheat is the most successful crop on the silty soils, because most of its growth is made at the time of the year when the supply of soil moisture is sufficient for fair or good growth. Other crops that are of minor importance are grown on these soils to a disadvantage because most of their growth takes place during the driest part of the growing season.

The silty soils have, in general, a limited amount of available moisture for most crops. The friable soil material in which moisture is readily stored extends to a depth ranging from 12 to 18 inches. Beyond this is the claypan layer which absorbs moisture very slowly and delivers it very slowly to the plant. Any moisture that may be available beyond the claypan is accessible to only a few roots, as a majority of them are restricted to the soil lying above the claypan. For that reason the available moisture is quickly consumed by the growing crops, and unless rains are frequent enough to replenish the available supply in the soil above the claypan, crops will soon suffer, as they often do during the driest part of the summer. During May, June, and the first part of July corn usually makes an excellent growth, with prospects of a good crop. After this, as the season becomes drier, the growth of the corn plant is retarded, because the supply of available moisture has been consumed. As a result the leaves shrivel and dry. The same thing follows with other crops grown in the summer on the silty soils. If there is plenty of rain in the spring, alfalfa generally produces one good crop, but later in the season very little growth is produced, usually not enough to warrant cutting. Kafir and related crops are better adapted to drier conditions than corn or alfalfa. They usually endure the entire season of dry weather without any harmful effect on the leaves, but their growth is greatly retarded.

Oswego silt loam, a soil of rather wide distribution, and Kay silt loam, alkali phase, belonging to the silty soils group, usually have a smaller amount of available moisture than other soils of the group. This is because the layer of friable soil material above the claypan, available for water storage, is thinner than the corresponding layer in the other members of the group. The thickness of the layer of friable material, including the surface soil and subsoil, in Oswego silt loam and Kay silt loam, alkali phase, in many places is not much more than 12 inches, whereas in other soil types it is in many places more than 18, and in some places as much as 20 inches. Therefore, crops growing on the former soils are the first to suffer from the effects of drought.

The other soils of the Kay and those of the Miller series of the silty soils group are more favorably situated, with regard to the supply of available moisture, than the Oswego soils and Kay silt loam, alkali phase. These soils occur in the valleys, and the subsoil lies near the water table, so that crop roots of extensive development can be assured of a constant supply of moisture. For this reason, alfalfa is commonly more successfully grown on the typical Kay and Miller soils than on either the Oswego soils or Kay silt loam, alkali phase. Farmers report that it is as difficult to get a stand of alfalfa on the Kay and Miller soils as it is on the Oswego soils and the alkali phase of Kay silt loam, but after it is once established it produces good crops.

Favorable moisture conditions persist for a longer time in the soils of the Renfrow series than in those of the Oswego series, because the friable material in which most of the moisture is available to growing crops is deeper. Therefore, the moisture-holding capacity is greater and crops have use of moisture for a longer period than crops on soils with a shallow subsoil. The depth to the claypan in Renfrow silt loam is 20 inches, whereas in Oswego silt loam it is only 12 inches.

Oswego silt loam.—Oswego silt loam has a gray or brownish-gray friable surface soil that grades, at a depth of 6 or 8 inches, into a friable very dark grayish-brown or black granular subsoil. This material continues downward, merging into a heavy brown or black plastic claypan at a depth of about 15 inches. In most places lime is present beneath the claypan layer at a depth of 36 inches. The surface soil shows a neutral or slightly acid reaction with Soiltex. When dry the soil is much grayer than when wet. On drying, the surface material forms a very hard crust that ranges from 2 to 3 inches in thickness, according to observations of soil conditions over a wheat-stubble field. Below this layer the material is more or less friable and of loose consistence. During the dry part of the summer, the surface soil shows a decidedly gray color over a plowed field. The material is more or less cloddy, owing to the breaking of the hard crust that was formed on the surface before plowing, but after harrowing a large part of the material is reduced to fine silt or powdery form.

The subsoil material in Oswego silt loam is also friable, but it is more granular than the surface soil. When dry it falls easily into small granular pieces that can be reduced easily to powder form. The subsoil is also darker, but in some places it is sprinkled with gray material that has sifted down from the surface soil. It perhaps

has a higher content of the clay material than the surface soil. The material in the claypan layer below the subsoil is very plastic and compact when wet. During the dry part of the summer it becomes very hard and shrinks, forming cracks that extend upward to the surface and that range from one-half to 1½ inches in width.

Oswego silt loam is typically developed on flat and gently undulating uplands where surface drainage is slow. After a long period of rainfall, water remains on the surface for an unusual length of time, as compared with the land having a more rolling surface.

Oswego silt loam, deep phase.—Oswego silt loam, deep phase, occupies large areas north of Lamont and west of Wakita, in which the surface soil extends downward to a depth of 24 inches before reaching the claypan layer. In such areas the land has a smooth gradual slope that descends from the uplands toward the valley bottoms. The thick layer of surface soil may be due to deposition from flood waters running down the slope during heavy rains. Owing to the thickness of the surface soil and the greater capacity to hold moisture, this soil is somewhat more productive than typical Oswego silt loam.

Renfrow silt loam.—Renfrow silt loam has a dark-brown friable surface layer which passes, at a depth of 6 inches, into a brown subsurface layer that is slightly heavier in texture. The subsurface layer, in turn, continues downward and passes into a brown or reddish-brown claypan of plastic tough clay at a depth ranging from 12 to 18 inches. Lime is present at a depth of 36 inches. In some parts of the county, the surface soil, when very dry, appears slightly red when viewed over a plowed field. In places where the land has considerable slope and approaches the Vernon soils, the subsoil of Renfrow silt loam is unusually red.

This soil occupies land of smooth or gently rolling relief adjacent to the drainageways and along ridges. Surface drainage is good. The soil differs from Oswego silt loam in that it has a brown subsoil and claypan and in some places has a browner surface soil. The surface relief is somewhat more undulating than that on which Oswego silt loam lies, and surface drainage is better. The largest areas are in the southeastern part of the county.

Renfrow loam.—Renfrow loam has a brown or reddish-brown loamy surface soil underlain by a light-brown or chocolate-brown friable clay loam subsoil. It differs mainly from Renfrow silt loam in that the surface soil contains a larger quantity of sandy material.

This soil occupies a very small acreage. A few small areas are scattered about the eastern part of the county between Lamont and Deer Creek.

Renfrow clay loam.—The color of the surface soil of Renfrow clay loam ranges from chocolate brown to dark grayish brown, but it is, in general, reddish brown. Recently plowed fields appear to have a redder surface soil than any of the upland soils in the county. The 2- to 4-inch surface soil consists of heavy granular clay. The subsurface soil is reddish-brown plastic clay when wet, but when dry it becomes very hard and forms wide cracks that range from one-fourth inch to 2 inches in width, and they extend up to the surface. The material in this layer is also rich in lime, and, for this reason,

sweetclover can be easily grown on this soil. A few farmers have grown sweetclover on it very successfully.

On account of the high clay content of Renfrow clay loam, great care must be taken to cultivate the surface soil under proper moisture conditions. It loses moisture very rapidly through evaporation, and therefore the proper moisture conditions should be watched and the land plowed immediately before the soil becomes too dry. It is a common remark in the county that "if the land of Renfrow clay loam is too wet to plow in the forenoon it will usually be too dry in the afternoon; therefore the best time to plow it is in the middle of the day." Wheat and sweetclover are the only two crops that can be successfully grown on this soil.

Kay silty clay loam.—Kay silty clay loam has a brown or dark-brown surface soil that passes at a depth of 12 inches into a subsurface layer which is darker than the surface soil. The subsurface soil continues downward to a depth of 24 inches where it merges with reddish-brown plastic clay, in which lime is first noticeable. The material of the surface soil contains a large quantity of clay, so that when wet it is very sticky but on drying it becomes very hard and cloddy. The material of the subsoil, on the other hand, may be similar, but in most places it is more compact and becomes very hard when dry.

Kay silty clay loam occurs only in the bottoms of Salt Fork Arkansas River, and the land is very flat, so that drainage is slightly restricted and very little of the surplus moisture is removed through run-off. There are numerous small wet depressions, ranging from 12 to 20 feet in diameter, in which water collects, and it escapes only through evaporation.

On account of the heavy-textured surface soil, heavy machinery and plenty of power is required to work this land. Wheat is the principal crop grown.

Kay silt loam.—Kay silt loam has a friable brown or grayish-brown silt loam surface soil that passes downward at a depth of 6 or 8 inches into a silty clay subsurface layer which continues downward to a depth of about 24 inches before it merges into reddish-brown plastic clay. The subsurface soil is darker and more compact than the surface soil. If examined in a very dry condition along road cuts, the material is very hard, and it breaks into hard, sharply pointed clods, but the material in a cultivated field under more moist conditions breaks easily into small clods.

Kay silt loam occurs on level terraces, on which surface drainage is slightly restricted. In areas where this soil is under cultivation it is advisable to have the land artificially well drained by constructing ditches across the fields so that the surplus surface water may escape.

The surface soil of Kay silt loam is darker than that of the soils of the Reinach series, although on parts of the bottom land where it is closely associated with the Reinach soils, in many places it shows a faint red color on the surface of plowed fields, but this may be due to the influence of the red material that has been transported over the Kay soils by either wind or water. In the most typical parts of Kay silt loam areas the surface is spotted with patches of

light-gray material, locally known as alkali spots. During dry weather the surface of these spots becomes hard, and the growth of corn or small grain is much shorter in these places than in other parts of the area. At this time the predominant grass growth in pastures is saltgrass—a grass that is most tolerant to dry alkali-soil conditions.

Kay silt loam, alkali phase.—Kay silt loam, alkali phase, has a dark-gray friable surface soil that merges at a depth of 5 inches into a brown clay subsurface layer that is very compact and plastic when wet and very hard when dry. The subsurface layer, in turn, continues downward to a depth of 12 inches, where it passes into sandy clay of rust-brown and gray colors, spotted with black concretions and concretions of lime.

The surface soil is decidedly gray when dry, and it develops a very hard crust when in this condition. The subsoil resembles the claypan developed in Oswego silt loam, except that in most places it is more brown. The surface is dotted with alkali spots, and the native vegetation is predominantly saltgrass and other species that prevail under such soil conditions.

During wet seasons this soil is poorly drained, on account of the flat surfaces and shallow depressions that are common over the land, although, on account of the impervious character of the subsoil and shallowness of the surface soil, very little moisture is retained. Consequently, after the surplus moisture on the surface has evaporated, the soil soon becomes droughty.

Kay silt loam, alkali phase, is developed on a high terrace east of Lamont, and in Gore Township in the western part of the county. It differs from Kay silt loam in that the surface soil is much more gray, and the soil contains much gravel and coarse sand mixed with the clay below the subsoil. This soil does not have the dark claypan subsoil that is developed in Kay silt loam. Wheat is practically the only crop grown.

Pond Creek silt loam.—Pond Creek silt loam is most extensively developed east of Nash, in the southwest corner of the county, where the land lies lower than that in the rest of the county, and the surface relief is unusually level. On account of the level surface relief, this part of the county is decidedly different from the surrounding country, which is hilly.

Pond Creek silt loam has a brown or dark-brown surface soil which extends downward to a depth of 20 inches, in some places to 36 inches. The second layer in many places is darker than the first, ranges from 12 to 15 inches in thickness, and is heavier than the first. It merges into the third layer, which is very similar in color but contains an abundance of lime. This layer, in turn, continues downward, changes with increased depth to more reddish brown in the lower part, and passes into a reddish-brown layer at a depth of 55 inches.

The material in the first layer of Pond Creek silt loam forms columnar blocks which average about 6 inches in width and 12 inches in length. The columnar blocks break in a horizontal direction, forming a very flat top, but in their natural form there is within the first 1 or 2 inches a loose structureless or partly laminated material that tends to form a rounded surface at the top. The rest of the

material in this layer has the appearance of granulation but for the most part breaks into irregular-shaped pieces having soft edges and corners. When moderately moist these pieces are easily crushed between the fingers to a fine silty texture. On a freshly broken surface many grass roots, insect casts, and wormholes are exposed. When examined under a magnifying glass the material appears to have been reworked by insects, as most of it is made up of abandoned wormholes and insect casts. On account of this condition, the entire mass of material is inclined to contain a large amount of air space, and its natural structure is easily altered through handling. Crushing the material shows no change in color in the surface layer to a depth of about 12 inches, but below this there is a slight change in color, indicating that the dark organic matter has thoroughly impregnated the soil particles, except below a depth of 12 inches where it only forms a dark coating on the outsides of the soil particles. In a few places a faint sprinkling of gray is detected on particles in the lower part of this layer.

The dark color of the second layer is evidently caused by a coating of dark organic matter on the outsides of the structure particles, as crushing the material produces a decided change in color from dark brown to yellowish brown or reddish brown. The material breaks into cubical pieces ranging from one-half to one-fourth inch in all dimensions. When moderately moist, these pieces are easily crushed between the fingers; but when dry, they are very hard. This layer is mostly free of insect life within the material, and only a few grass roots are present, as compared with the number in the first layer.

The color of the material in the third layer changes gradually from that of the dark-colored layer above to that of the red layer below. Lime is evidently more abundant in this layer than in any other layer, as effervescence is produced over most of the material when tested with hydrochloric acid, but wherever acid is applied to any other part of the profile, effervescence is produced in spots where lime happens to occur. Lime occurs mostly in a soft almost white form, and it either follows seams and cracks or is present in finely disseminated form throughout the soil mass. Lime, in a hard concretionary form, occurs in a very insignificant quantity.

The fourth layer consists mostly of parent material which is developed from soft sandstone of very fine texture. The material is reddish brown and breaks into irregular-shaped pieces and becomes softer with increased depth. Effervescence with acid is produced in spots, and as depth increases there is finally no effervescence.

Inherently this soil is slightly less productive than the best upland soil. This is due to the moderately heavy second layer which tends to influence unfavorably its water-holding and water-delivering capacity. This condition affects its productivity for corn to a greater extent than for wheat, since the latter crop matures before the dry weather of midsummer.

Miller clay loam.—Miller clay loam has a chocolate-brown or reddish-brown surface soil which passes, at a depth of 4 or 6 inches, into a reddish-brown plastic clay subsoil. This material continues downward to a depth of 36 or more inches without any change in either color or texture. The subsoil is rich in lime to a depth of many feet. In a few places the surface soil has a high content of lime.

Miller clay loam is very similar in general characteristics to Renfrow clay loam, and the only difference between these two soils is that Miller clay loam occurs in the valley, whereas Renfrow clay loam prevails on the uplands. Miller clay loam, however, has a little advantage over Renfrow clay loam as a producer of crops, because of the fact that it occurs on the bottom lands where more moisture is available on the surface and where moisture in many places is furnished through subirrigation.

SANDY SOILS

A friable soil material throughout a profile is a favorable condition for growing crops in the sandy soils, as it provides the maximum amount of available moisture for plant growth. The moisture which falls on the surface penetrates the soil very readily, a very small amount being lost by run-off or evaporation. A large amount of moisture can therefore be stored and later used by the growing crops. For this reason, plants will have sufficient moisture for a much longer time, when the rainfall is equal on both kinds of soils, than crops growing on the silty soils which have a limited capacity for moisture storage. Such crops as alfalfa, which requires large quantities of moisture, can easily maintain steady growth to maturity under such soil conditions; whereas in soils where the supply is limited it is soon exhausted and crops suffer. During the summer of 1930, it was observed that corn on the silt loam soils was badly damaged by the drought, but on the sandy soils a fair crop yield was obtained. Alfalfa also made a larger yield on a few of the sandy soils than on any of the silty soils. Wheat produces excellent yields on a few of the sandy soils because of these favorable moisture conditions, but, in general, the yields are no greater than those obtained on the silt loam soils. The quantity of available moisture, which in many places is the limiting factor in crop growth, is nearly everywhere sufficient in the silty soils at the time wheat makes most of its growth, and therefore no difference in growth of wheat can be detected between wheat on sandy soils and that on the silt loam soils.

Practically all the soil types of the sandy soils group, with the exception of Derby loamy sand, are adapted to the successful growing of a wide diversity of crops, and, wherever a farm consists entirely of these sandy soils, the acreage is fairly evenly divided among corn, oats, and wheat, and a considerable acreage is devoted to growing alfalfa.

Derby loamy sand.—Derby loamy sand has a brownish-gray or grayish-brown loose structureless sandy surface soil. The subsoil commences at a depth of about 6 inches below the surface and consists of brown or reddish-yellow loose incoherent sand that is uniform in character to a depth of 3 feet or deeper. Neither the surface soil nor subsoil contains sufficient lime to produce effervescence with acid. In many places the surface soil shows an acid reaction.

This type of land is somewhat uneven in relief, the surface being dotted with a number of low mounds from 2 to 4 feet high. Numerous swales or depressions separate the low mounds, and the water stands in them after heavy rains. The darker colored material is perhaps washed off from adjoining mounds into these low places,

so that the surface soil is darker in many of these places than on the surfaces of the low mounds. On account of the loss of organic material by erosion or wind action, the surface material on the higher parts of the land is more accessible to wind action and crops are therefore apt to be destroyed by drifting sand.

About 60 percent of this soil is under cultivation. It is the only type of sandy soil on which crop production is confined chiefly to one or two varieties of crops. Row crops, or what may be termed feed crops, are predominant. They include corn, kafir, hegari, milo, and several varieties of sorghum grain crops, but these crops are not so productive on this soil as on other types of the sandy soils. The plants seldom produce as vigorous growth as on other soil types. They are usually short and not fully developed, ears forming on the stalks are small, and the yield is very low. Corn on this soil can be used to the best advantage when the stalks are cut for fodder, and through this means an abundance of forage can be obtained. Other feed crops grown on Derby loamy sand are often not so vigorous as those grown on the more productive soil types of the sandy soils group.

The low state of productivity of Derby loamy sand, as compared with the more productive sandy soils, is probably not due so much to moisture conditions as to low fertility. Investigation proves that an abundance of moisture is present within reach of the crop plants, as in some places the water table is reached at a depth ranging from 50 to 65 inches. The soil, however, judging by the appearance of the gray surface soil and subsoil, shows that it may be low in organic matter and possibly nitrogen and other elements necessary to make a soil productive.

Derby loamy sand is most typically developed in the western part of the county. Farther to the east, especially east of Pondcreek, the land is slightly more productive, and corn makes a better growth. This may be because, at a depth ranging from 36 to 60 or more inches, dark reddish-brown clay material is reached. This material acts as a check in the downward percolation of moisture and thus forces storage of moisture at a depth that makes it most accessible for growing crops. In the western part of the county this heavy material, however, is present at greater depth, and consequently moisture stored in the material above it is not in easy reach of crop roots.

Another crop that is grown principally on Derby loamy sand is watermelons. The largest acreage devoted to this crop occurs along Salt Fork Arkansas River, between Pondcreek and the eastern end of the county. In this district farmers have organized a watermelon growers' association, and each year several carloads of melons are shipped from Lamont and Pondcreek for the eastern and northern markets.

Derby fine sandy loam.—The surface soil of Derby fine sandy loam consists of dark-brown friable sand or loamy sand, which passes, at a depth of 6 or 7 inches, into a brown fine sandy clay subsurface layer, and this, in turn, continues downward to a depth ranging from 24 to 36 inches before merging with reddish-brown clay. In general, the surface relief of this land is level or undulating, and it is modified by many low mounds and shallow depressions.

Surface drainage is good over most of the land, except in a few of the shallow depressions where, in many places, the soil material is much heavier and therefore causes the surplus moisture to remain on the surface.

The surface soil of Derby fine sandy loam is much more stable than that of Derby loamy sand, as it does not shift about so readily through the influence of wind action. The subsoil is decidedly browner and contains a larger proportion of clay than the subsoil of Derby loamy sand.

Derby fine sandy loam is a very productive soil, on which wheat, oats, and corn can be successfully grown.

Derby fine sandy loam, reddish-brown phase.—The surface soil of Derby fine sandy loam, reddish-brown phase, consists of brown or grayish-brown friable material. In cultivated fields it has a slight red tinge, as compared with other soils of the Derby series. The subsurface soil begins at a depth of about 6 inches. It consists of brown or reddish-brown friable silt loam which passes, below a depth of 14 inches, into reddish-yellow very fine sandy loam. The material in neither the surface soil nor the subsoil contains sufficient lime to produce effervescence with acid.

This soil forms a comparatively wide strip along both sides of Sand Creek in the western part of the county. The surface relief, in general, is level, and it is modified with numerous depressions or swales and low mounds. Surface drainage is good, owing to the friable surface soil which allows moisture to be readily absorbed.

Grant very fine sandy loam.—Grant very fine sandy loam is characterized by a brown or grayish-brown loose friable surface soil that passes, at a depth of 12 inches, into a brown or reddish-brown subsurface layer, similar in texture to the surface soil. The subsurface soil continues downward to a depth of 36 or more inches, and lime is present at a depth ranging from 50 to 72 inches.

This soil is noted for its extremely friable material in the surface soil and in the subsoil to considerable depths. The surface soil has a good mellow consistence and is easily cultivated. A firm seed bed is easily produced under wide variations in soil moisture conditions.

This soil has very nearly the same characteristics as Reinach very fine sandy loam. Grant very fine sandy loam is most extensively developed in the northwestern and southwestern corners of the county. It occurs only in smooth, long, gently sloping upland areas. Over cultivated land the surface of this soil appears slightly reddish brown, similar to the color developed on the surface of Reinach very fine sandy loam.

Drainage is good, as the surface relief allows surplus moisture to escape through run-off. However, surplus moisture only escapes in this way, and since the surface soil absorbs water readily a very small amount escapes.

Corn is more successfully grown on Grant very fine sandy loam than on any other upland soil. When corn is known to suffer from the effects of drought on other upland soils no ill effects can be seen on corn growing on this soil.

Grant very fine sandy loam, shallow phase.—The shallow phase of Grant very fine sandy loam is distinguished from the typical soil by the slight depth to bedrock. Over most of the area included in

this phase, the sandy shale beds outcrop in many places on a sloping surface, and over the smoother parts of the land these beds lie within 24 inches of the surface. The surface soil of the more level bodies is brown or grayish-brown friable material which passes at a depth of 7 inches into a brown or reddish-yellow friable subsurface soil.

This shallow soil is most extensively developed in the northwestern and southwestern parts of the county.

Grant silt loam.—The 7- or 8-inch surface soil of Grant silt loam consists of very fine material ranging from very fine sandy loam to silt loam. The subsurface soil is brown granular silt loam which is very friable and very easily penetrated with a spade to a depth of 36 or more inches. The color of the subsurface soil changes to reddish brown at a depth of 20 inches. In many places lime is present at a depth of 60 inches, but in some places none occurs within a depth of 72 inches. A small quantity of gravel and fine sand is present in or below the subsoil, at a depth of 36 or more inches. This material is a characteristic feature of Grant silt loam, and roads traversing this land are naturally surfaced with the gravelly material.

The largest body of this soil begins northeast of Jefferson and continues eastward in disconnected ridges to the eastern part of the county.

A good mellow surface soil and a deep friable subsoil makes the land very productive, and a wide diversity of crops can be successfully grown on it. Wheat, corn, and alfalfa are the principal crops.

Grant silt loam lies on nearly the same kind of surface relief as Grant very fine sandy loam, and the two soils are about equally productive. The silt loam differs from the very fine sandy loam in that the material below the subsurface soil contains some fine gravel and sand, and in some places the material in this layer is noncalcareous, whereas Grant very fine sandy loam consists of uniform material of very fine texture to great depths, and lime is everywhere present below the subsoil.

The color of the surface soil of Grant silt loam is uniform, except in a few places on ridges and steep slopes where surface erosion has been severe. In such places the soil exposed at the surface is redder. Along the lower parts of long gradual slopes that finally merge with land characterized by heavy claypan soils, the material below the subsoil of Grant silt loam in many places differs from the typical material. Instead of gravel and a loose friable material, there is a dark grayish-brown claypan, but it occurs at sufficient depth that it has very little influence on crop growth. In most places along such slopes a deeper surface soil prevails, and the soil contains a large quantity of material that has been washed down from higher land.

Grant loamy very fine sand.—A very small area of Grant loamy very fine sand lies along the western boundary of the county a short distance south of the point where Salt Fork Arkansas River enters. On account of the common occurrence, within this part of the county, of sandy material accumulated by wind and the same kind of material in the lower part of the Tertiary deposits, it is in some places difficult to determine the exact source of the material. This is true of the area identified here as Grant loamy very fine sand. Not-

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withstanding this doubt as to source of the material from which this soil has developed, the soil for all practical purposes is Grant loamy very fine sand. It could have been designated Derby loamy very fine sand, the soil with which it would have been identified had it been possible to prove that the material had been accumulated by wind action. However, the chemical and physical composition of this material being loamy very fine sand is the important matter rather than its geological source.

The soil, to a depth of about a foot, is brown or grayish-brown very fine sand ranging to light loamy very fine sand. It is underlain by a stronger colored, faintly reddish brown loamy very fine sand layer which may be as much as 4 feet thick. The subsoil may consist of loamy very fine sand, essentially identical in its mechanical composition with the subsurface soil, or it may consist of somewhat loose very fine sand. In either case the color is grayish brown or yellowish brown rather than reddish brown.

The single area in which this soil occurs is used mainly for pasture, corn, or grain sorghums. It is not an important soil, either in area or in productivity.

Reinach very fine sandy loam.—The surface soil of Reinach very fine sandy loam consists of brown friable material that extends downward to a depth of about 10 inches before merging with the brown or reddish-brown subsurface soil of very fine silt loam. This layer, in turn, passes downward and changes to the reddish-brown silt loam subsoil at a depth of 24 inches. Lime occurs at a depth of about 40 inches. The thick mellow surface soil allows moisture to be readily absorbed by the subsoil. On account of such a friable condition of the surface material, the land is easy to cultivate in the preparation of a good firm seed bed. Clods formed in plowing are readily reduced by harrowing.

This soil occurs on second bottoms, or terraces, where good drainage prevails. It is very highly prized, and crops grown on it are rarely known to fail. Corn and alfalfa produce excellent yields, and watermelons of good quality are produced.

Reinach silt loam.—Reinach silt loam differs from Reinach very fine sandy loam in that it has a finer textured surface soil and subsoil, but the two soils are very similar in other characteristics. Reinach silt loam occurs on high terraces adjacent to the uplands, whereas Reinach very fine sandy loam occupies the same terrace but mainly that part adjacent to the river or first bottom.

The surface soil of Reinach silt loam is brown, and it is friable. The subsurface soil, commencing at a depth of 6 inches, is light-brown friable silt loam that continues downward to a depth of about 18 or 20 inches, where it is underlain by a reddish-brown friable clay loam subsoil. Lime in sufficient quantity to produce effervescence with acid is present at a depth of 36 inches.

Yahola loamy sand.—The 12-inch surface soil of Yahola loamy sand is brown or faintly reddish brown very fine sand or loamy very fine sand. The subsoil is slightly heavier than the surface soil and is predominantly reddish-brown loamy very fine sand. Below a depth ranging from 3½ to 5 feet, the material consists of grayish-brown fine sand. The lower part of the subsoil and the underlying fine sand are calcareous.

Only one area of this soil is mapped. It lies near the western boundary near the point where Salt Fork Arkansas River crosses the county line. The land is moderately productive for sorghums, cowpeas, and alfalfa, but somewhat less so for corn.

Yahola very fine sandy loam.—The 6-inch surface soil of Yahola very fine sandy loam consists of reddish-brown mellow friable very fine sandy loam that is underlain by a brown or dark reddish-brown friable subsoil. At a depth of 14 inches, the color changes to light reddish brown, and farther down, at a depth of 30 inches, the soil material is exceedingly friable very fine sand. In many places the surface soil is alkaline in reaction, and lime is present throughout the subsoil.

Yahola very fine sandy loam differs from Reinach very fine sandy loam in that the material is calcareous at a much slighter depth than in the Reinach soil. Below the subsoil in the Yahola soil, at a depth ranging from 24 to 36 inches, is a substratum of fine porous material, whereas in the Reinach soil the material below the subsoil in many places is similar or in some places heavier in texture than the surface soil to a depth of 72 or more inches. The surface soil of the Yahola soil is much redder than that of the Reinach soil.

Yahola very fine sandy loam occurs only in stream bottoms. It is subject to frequent overflows during seasons of heavy rainfall. Practically all the land is in cultivation. It is a very strong and fertile soil, especially adapted to the production of watermelons.

Yahola silt loam.—Yahola silt loam has a reddish-brown friable surface soil that merges into a subsurface soil of dark reddish-brown friable silt loam. This layer, in turn, continues downward and passes into light reddish-brown friable very fine sandy loam at a depth of 30 inches.

Most areas of Yahola silt loam border alluvial flood plains adjacent to the uplands where a large quantity of silty material is deposited by the flood waters from the river. This accounts for the development of a heavier soil than is common in the Yahola soils along the flood plain. Yahola silt loam differs from Yahola very fine sandy loam only in the texture of the surface soil.

Osage silt loam.—The surface soil of Osage silt loam is very dark grayish-brown or dark grayish-brown friable silt loam. The subsoil, commencing at a depth of 8 inches, is dark grayish-brown friable silt loam which continues to a depth of 36 inches where it passes into friable dark reddish-brown clay loam.

This soil occurs on the well-drained bottom land of the small tributary streams of Salt Fork Arkansas River. It is subject to overflow after heavy rains, but the surplus surface moisture that collects during these periods immediately escapes through run-off after normal conditions return in the streams.

Osage silt loam is the darkest bottom-land soil in the county. The color of the surface soil is uniform in most parts of the areas in which it occurs, although in a few places, where red material has been washed down from the uplands, the surface soil is slightly red. However, this variation does not cover a large enough territory to warrant mapping as a phase of Osage silt loam. The darkest colored areas occur in the valley southeast of Deer Creek. In this

locality the land is level and flat, and the surface soil is slightly heavier than that which has developed in most parts of the areas of Osage silt loam.

UNTILLABLE LANDS

The untillable lands of Grant County include land that is either too rough for cultivation or too sandy for crops to grow well. Such soils are Vernon clay loam, eroded phase, Derby loamy sand, shallow phase, Derby sand, and Grant very fine sandy loam, eroded phase. It must be remembered, however, that small areas of these soils are used for crop production.

Vernon clay loam, eroded phase.—Vernon clay loam, eroded phase, includes rough badly eroded areas commonly known as " red-clay land." The surface of the land occupied by this soil is cut by many gullies. Wherever any part of the land is smooth, the red unweathered clay is exposed on the surface. Along the bluffs of a stream the slope is cut into steep precipitous walls exposing "Red Beds " to a depth of several feet. The material is rich in lime even in the surface soil. The surface soil when moderately moist is friable and granular, but the subsoil is very heavy and plastic. When dry the subsoil material is extremely hard to break with a spade.

Grasses, such as bluestem, bunch grass, and some grama and buffalo grass, comprise the vegetation over this soil, and they provide considerable quantities of feed for livestock that are pastured on the land, provided it is not heavily pastured.

Grant very fine sandy loam, eroded phase.—The eroded phase of Grant very fine sandy loam includes the badly eroded areas of Grant very fine sandy loam along streams, where the slopes are steep, or on divides, where erosion has removed a large part of the thin layer of soil that was superimposed on the beds of sandstone and shale. The general surface of the land occupied by this soil is rough and dissected by numerous drainageways.

Derby sand.—Derby sand has a gray or brownish-gray surface soil underlain, at a depth ranging from 4 to 6 inches, by brownish-yellow or reddish-yellow loose incoherent sand that continues to a depth of several feet. The surface relief is smooth and hummocky, and the land in most places is covered with a sparse growth of bunch grass, but in places there is considerable timber. The surface soil is very loose and is easily eroded by wind, wherever the land has been disturbed by overgrazing or wherever the material has been recently deposited by wind. In such localities the smooth surface is modified by blow-outs and shifting sand. The surface characteristics of Derby sand have been greatly influenced by wind action, as most of the soil material has been transported and deposited by the wind. Along Salt Fork Arkansas River near Lamont, and around Mountain View School, the surface of the sandy deposit in some places is more than 50 feet above the general level of the bottom lands.

Land of this kind is used mainly for pasture.

Derby loamy sand, shallow phase.—Derby loamy sand, shallow phase, embraces areas of the sandy lands where the water table lies at so slight a depth as to cause the surface soil to be saturated with moisture during the wet season of the year. During most years this condition provides plenty of moisture for grasses throughout the

growing season, in spite of the droughty period that generally occurs during the summer.

The 6-inch surface soil is grayish-brown loamy sand which grades into a brown or yellowish-brown sandy subsoil, and this layer, in turn, continues downward, passing at a depth of about 30 inches into heavy sandy clay material. This sandy clay is much closer to the surface in Derby loamy sand, shallow phase, than in any other member of the Derby series, and therefore the water table is much closer to the surface.

Derby loamy sand, shallow phase, occupies the low flat areas of sandy land in Grant County. Land of this kind is used for grazing or for hay meadow.

SOILS AND THEIR INTERPRETATION

The soils in Grant County have developed under rather uniform climatic conditions. They have also developed under a wide variety of local conditions which have a more or less modifying effect on the natural processes of soil development, thereby producing several types of soil. Wherever the soil includes level, well-drained land, certain common profile characteristics are persistently developed, but on steep slopes or on alluvial lands various kinds of soil features have been produced. On the steeper slopes the soil is thinner than on the more nearly level areas. This is partly due to erosion and removal of the surface soil and partly due to the fact that more soil material runs off the slopes, leaving less available for the growth of plants and soil development. On the alluvial lands the surface is frequently altered by additional deposits of material, so that most of the soil throughout the profile is of such recent formation that not enough time has elapsed to produce any persistent soil characteristic. Most of the soils on the stream bottoms have profiles that are fairly uniform in texture, structure, color, and chemical nature, but wherever there is a variation in the character of the profile from top to bottom in recent alluvium, it is due to the difference in the kinds of material that were deposited on the surface at different periods.

The survey in Grant County identified several soil types on the basis of their soil characteristics alone. These characteristics were either developed through the influence of climate and vegetation or through the modifying effects of local conditions on the soil profile. For convenience in discussion, the soils are classified in two broad groups on the basis of some common soil characteristics. The soils of the sandy loam group have sandy surface soils which range from silt loam to loamy sand, and they are friable throughout. The soils of the silt loam group have much finer textured surface soils that range from silt loam to clay loam, and most of the soil types, except those of the Pond Creek series, have heavy clay subsoils. The soils of the sandy loam group occupy a narrow belt across the western end of the county and the valley of Salt Fork Arkansas River. The silt loam soils cover the rest of the county.

The silt loam soils include members of the Oswego, Renfrow, Kay, Miller, Pond Creek, and Vernon series. Most of these soils, with the exception of the Miller and Vernon, have certain general profile char-

acteristics. One of these is the claypan, or a compact horizon, and another is a horizon in which more lime is present than in the layer above or below. The claypan horizon lies at an average depth of 15 inches below the surface in the Oswego soils, 20 inches in the Renfrow, and 10 inches in the Kay. The material in this horizon is extremely hard when dry, and vertical cracks 1 inch wide occur here and there throughout the claypan. The material breaks out in large irregular-shaped pieces which can be reduced to smaller units only with the use of a pick or hammer. The color of the claypan material ranges from dark grayish brown to reddish brown, everywhere grading to reddish brown with increased depth. Very few grass roots penetrate this horizon. Many road cuts show that a large proportion of the root systems of trees follow a horizontal direction in the upper part of the claypan horizon.

The horizon of lime accumulation occurs below a depth of 36 inches in the Oswego and Renfrow soils, and in the Kay soils below 24 inches. The material in this layer consists of yellowish-brown or reddish-brown clay which is in general more easily penetrated with a spade or auger than is the material in the overlying claypan horizon. When dry the material is very hard, but it breaks naturally into smaller units, many of which are prismatic in shape. Lime is distributed in this horizon in the form of hard concretions that average about one-fourth of an inch in diameter. The concretions are irregular in shape, and most of them have hollow centers. Lime occurs also in a finely disseminated form that can only be detected when an application of acid produces effervescence. A few concretions of manganese are also present in this horizon.

Soils having the characteristics mentioned occupy flat or smooth gently rolling well-drained areas, but the soils of Miller clay loam and Vernon clay loam, which do not have certain features common to the soils on level areas, have a different kind of environment. Vernon clay loam occupies more or less severely eroded slopes, and Miller clay loam occupies alluvial bottoms where additional deposits of red clay material are frequently made on the surface. Other minor profile characteristics of these soils will be given in detail in subsequent pages of this report.

The profile of Oswego silt loam, as examined in the SW¼ sec. 24, T. 28 N., R. 4 W., may be divided into four color horizons that merge into each other in a vertical direction. The first horizon, beginning at the surface, is dark brown or grayish brown. In the first 6 inches of this horizon the material is exceedingly friable and of single-grain structure, and it is sprinkled with considerable almost white material. When dry the material in this part of the horizon presents a very gray cast on the surface of cultivated land. The lower part of this horizon is darker and contains more fine material or clay, and it is more or less granular. Over large pieces of this material a sprinkling of gray material is detected, but when wet the gray color disappears. All the material in this horizon is easily crushed to a fine structure. A larger proportion of insect casts occur in this horizon than in any other part of the profile, and more grass roots enter the soil. In many places the material in this horizon shows an acid reaction.

The second horizon of the profile is readily detected, when penetrating through the friable material of the first horizon, by the sudden resistance given to the spade at a depth of about 15 inches. In this horizon the material consists of very dark grayish-brown or almost black waxy clay that is extremely plastic when wet and very hard when dry. The color changes to a grayish cast on the faces of the cuts when the soil is dry. Very few roots are evident in this horizon.

At a depth of about 30 inches the second horizon merges into a third horizon that in many places presents a grayish-brown or yellowish-brown color on the face of a road cut. The material is similar in structure to that of the second horizon, breaking into large massive sharp angular pieces, but it apparently contains a larger quantity of lime than occurs in the second horizon or in any other part of the profile. Effervescence is produced when acid is applied to the material in the third horizon, but in most other parts of the soil profile effervescence is faintly developed, or in most places there is none at all. Lime occurs both in concretions and in finely disseminated form. A few concretions of manganese are also present.

The fourth horizon underlies the third horizon at a depth of 55 inches, and it continues downward the entire depth of the cut, which is about 90 inches. This horizon consists of yellowish-red or reddish-brown friable clay. Effervescence with acid was faintly developed in a few places in this horizon, but in most places no effervescence was produced. This horizon represents the unweathered part of the parent material of the Permian " Red Beds."

Oswego silt loam occurs on flat divides where surface drainage is slightly restricted. Shallow depressions are numerous over the surface, and most of them are filled with water during very wet seasons. The only way that moisture escapes from the depressions is either through evaporation or absorption by the surface soil, the larger part escaping through evaporation.

The extreme flatness of the surface, modified with numerous shallow depressions, has an influence in the profile development of Oswego silt loam. Wherever the surface is more gently rolling and surface drainage is better, the profile is redder from top to bottom, and the claypan horizon is not so well defined in its development and also occurs at a greater depth below the surface than is common in the profile of typical Oswego silt loam. The flat surface with its many depressions, as is characteristic of Oswego silt loam, brings about an unusual supply of moisture for the surface soil, as compared with soils of more rolling surface relief. As a result the surface soil is darker than in the better drained areas where less moisture accumulates. However, in this very wet condition, the surface soil is being leached of its organic matter, together with fine colloidal clay. This results in the development of a dark-colored claypan and a gray surface soil. Other soils developed under a condition similar to that of Oswego silt loam include those of the Kay series.

The profile of Kay silt loam, as examined in the NE¼ sec. 16, T. 26 N., R. 5 W., and elsewhere, may be divided into three horizons. The first horizon is grayish brown, in some places having a faint red tinge. This horizon rests on a dark grayish-brown or almost black

clay horizon, the second horizon, which occurs between depths of 12 and 24 inches, and beneath this is the third horizon consisting of reddish-brown friable clay. This horizon, in turn, continues downward to a depth of 60 inches where the parent material of red clay is reached.

These horizons differ from one another in certain soil characteristics. The material in the first horizon is exceedingly friable and of single-grain structure, but that in the second horizon is very hard and when dry breaks away from the vertical wall in large sharply pointed clods that are very hard to reduce to smaller units by hand. The material when dry is as hard as the material in the claypan horizon of Oswego silt loam, but when it is moderately moist it breaks much more readily into small pieces. The compactness of this material may be due to the cementing power of the salts in the material under dry conditions. The material that renders the second horizon darker than the first forms a thin coating over the large soil particles. When this material is crushed, the color changes to yellowish brown or reddish brown. The material in the third horizon is more or less friable when moist but is hard when dry. It is not, however, so hard as the material which prevails in the second horizon. It contains lime both in concretionary and finely disseminated form at a depth ranging from 36 to 50 inches.

Patches of gray or white alkali, sporadically distributed on the dark-colored surface of Kay silt loam, are characteristic of these soils. The predominance of saltgrass is another important feature on pastured areas of the Kay soils.

Kay silt loam occurs on flat terraces where surface drainage is slightly restricted. During wet seasons water stands in pools on the surface, and the only way it escapes is through evaporation. Kay silty clay loam has the same profile characteristics as those described for Kay silt loam. The only difference between the two soils is that the surface soil material of the silty clay loam is much heavier.

The soils of the Kay and the Reinach series are closely associated with each other on the same terrace, the Kay soils in most places forming a narrow belt bordering the terrace next to the uplands, and the Reinach soils predominating along both sides of the stream. In many places, however, there is evidence that the Kay soils originally occupied all the terrace, even up to the stream banks. This is apparent in many deep cuts on the banks of streams, a profile of the Kay soils outcropping beneath a profile of the Reinach soils. The Reinach soil material has been more recently accumulated than that of the Kay soils. This material was deposited along the banks of a stream by overflow, as a natural levee. Later some transportation of this material, either by wind or water, onto the terrace has taken place. By this means a red tinge has been given to the surface soil of the Kay soils. But farther from the banks of the stream, or on that part of the terrace adjacent to the uplands, the surface soils of the Kay soils are darker than the surface soil near the stream.

The Renfrow soils have about the same profile characteristics as the soils of the Oswego series, in that they have a claypan horizon between depths of 16 and 36 inches and a horizon where the largest proportion of carbonate in the profile occurs, but they differ from the Oswego soils in a reddish-brown color of both surface soil and claypan.

The Grant soils have developed from comparatively young water-laid materials which are rather coarse. All these materials were and still are, where not leached, somewhat calcareous. Some of the material seems to consist of old terrace deposits, now eroded into a rolling relief, lying along Salt Fork Arkansas River. The part lying in the northwest part of the county, however, constitutes the extreme east end of the subaerial deposits of Tertiary age covering that part of the Great Plains west of this longitude, where not removed by later erosion. The material from which the Grant soils in the southwestern part of the county were developed is of less clearly defined origin. It is in part apparently a river terrace remnant. The rest of it may be a remnant of the Tertiary deposits or it may be merely well-drained (because of the rolling relief) residual material from sandy Permian rocks.

The outstanding feature of the Grant soils is their normal character. They are soils which have developed under the operation of climatic conditions and the forces of organic life, mainly plant life, unmodified by local conditions of poor or imperfect drainage or high percentages of salts. These soils have practically a normal south Chernozem profile, slightly degraded because of their occurrence along the extreme eastern border of the possible occurrence of true Chernozem soils in Oklahoma.

A profile of Grant very fine sandy loam, examined in the SE¼ sec. 4, T. 25 N., R. 6 W., has a dark-brown or brown surface soil that merges at a depth of 12 inches into a reddish-brown horizon of very fine sandy loam. This horizon, in turn, continues downward to a depth of 48 inches and passes into a third horizon that consists of calcareous material. This is the first appearance of calcareous material below the surface soil. In this horizon the material consists of loose friable very fine sandy loam which continues to a depth of 96 inches, where sandstone and sandy shale are reached.

Wherever lime is present below the subsoil in Grant very fine sandy loam, concretions ranging from 2 to 6 inches in diameter are in evidence. They are similar in shape to those of ordinary size occurring in other soils of the county. The depth to lime is variable in this soil. In places it may be only 30 inches, and in other places, as in the SE¼ sec. 17, T. 27 N., R. 8 W., lime is present at a depth of 72 inches.

Grant very fine sandy loam is extensively developed only in the northwestern and southwestern corners of the county, and the surface relief of the land which this soil occupies is smooth and gently rolling.

The Derby soils are derived mostly from sandy material ranging in thickness from 2 to several feet. The surface material ranges from sand to fine sandy loam in texture, and it passes at a depth of about 6 inches into a brown or reddish-brown incoherent sandy subsoil. This horizon, in most places, continues downward to a depth of several feet, with no change in texture and color. Wherever the surface soil has an unusually red tinge, a reddish-brown phase of this soil has been identified. Lime is not present in sufficient quantity in the sandy material of the profile of the Derby soils to produce effervescence with acid.

The profile of the Derby soils does not have any distinct development, so that it may be divided into several horizons on the basis of texture or the color of the material. With the exception of a slight

darkening of the surface material, there is no marked change brought about in the entire profile through the forces of soil development, as in the mature soils of the Renfrow or Oswego series. Therefore, these soils may be considered immature, and their immaturity may be due to the character of the parent material, which is very resistant to weathering.

Derby fine sandy loam occupies a transitional belt between the area of sandy soils and the area of heavier soils. A surface modified with numerous sandy mounds and shallow depressions of heavy clay soils is the characteristic feature of Derby fine sandy loam. The shallow depressions are too small to indicate on the map and are therefore included as a feature of this soil. The soils in the depressions include spots of Oswego silt loam. Most of the excavations made in Derby fine sandy loam extend downward into heavy clay material that is similar to the Oswego silt loam subsoil; therefore, this soil appears to be developed from sandy material that has been deposited in low mounds on the surface of an area originally occupied by the Oswego soils.

Derby fine sandy loam, as examined in the SW¼ sec. 15, T. 27 N., R. 7 W., has a grayish-brown fine sandy loam surface soil which, at a depth of 8 inches, is underlain by a brown fine sandy subsoil. The subsoil continues downward, passing at a depth of 24 inches into the third horizon of brown sandy clay, mottled with yellow and rust brown. At a depth of 48 inches is a layer of dark grayish-brown plastic clay, and in this layer is the first calcareous material below the subsoil.

In the eastern part of Grant County, where this soil is developed, a different kind of material occurs at the corresponding depth of the dark clay layer described. In the SW¼ sec. 24, T. 26 N., R. 3 W., the material consists of brown clay or sandy clay that is noncalcareous to a depth of 72 inches, where it has a decidedly red tinge. However, above this layer the usual surface soil and subsoil characteristics prevail over all the areas mapped as Derby fine sandy loam.

RECOMMENDATIONS FOR THE MANAGEMENT OF GRANT COUNTY SOILS [1]

A careful study of soil conditions in Grant County indicates that nitrogen is the most important limiting plant nutrient in crop production. Cropping systems have been used which have removed large amounts of nitrogen from the soil, and the potential supply of total nitrogen and organic matter in the soil is gradually decreasing. In order to obtain information concerning the loss of total nitrogen as a result of cultivation, 9 samples of cropped soil were collected and compared with 9 samples of virgin soil taken from adjacent areas of grassland. The results of the analyses are given in table 5. Although these soils have not been farmed longer than 40 years, 37 percent of the total nitrogen and 22 percent of the total phosphorus content of these soils have disappeared during that period. It is evident that this decrease of plant nutrients in the soil may eventually result in a reduction in crop yields.

[1] This section of the report was written by H. J. Harper, professor of soils, Agronomy Department, Oklahoma Agricultural and Mechanical College.

TABLE 5.—*Effects of cropping on the total nitrogen, total phosphorus, and acidity in certain soils of Grant County, Okla.*

Soil type and sample no.	Total nitrogen per acre in soil 6⅔ inches deep	Total phosphorus per acre in soil 6⅔ inches deep	Soil acidity
	Pounds	*Pounds*	
Reinach sandy loam:			
297 [1]	1,425	680	Neutral.
298 [2]	895	745	Basic.
Loss	530	[3] 65	
Pond Creek silt loam.			
443 [1]	1,650	400	Slight.
444 [2]	1,130	290	Medium.
Loss	520	110	
Grant fine sandy loam:			
1115 [1]	2,920	670	Slight.
1116 [2]	1,475	505	Do.
Loss	1,445	165	
Reinach very fine sandy loam:			
1128 [1]	2,610	485	Neutral.
1127 [2]	2,195	510	Do.
Loss	415	[3] 25	
Reinach fine sandy loam:			
1140 [1]	2,345	800	Do.
1139 [2]	2,320	770	Slight.
Loss	25	30	
Renfrow silt loam:			
1182 [1]	3,505	805	Do.
1181 [2]	2,290	585	Medium.
Loss	1,215	220	
Renfrow silt loam:			
1186 [1]	4,250	725	Neutral.
1185 [2]	2,050	455	Slight.
Loss	2,200	270	
Grant very fine sandy loam:			
1266 [1]	3,745	1,220	Medium.
1265 [2]	1,605	625	Do.
Loss	2,140	595	
Grant fine sandy loam:			
1442 [1]	2,465	725	Basic.
1441 [2]	1,680	585	Neutral.
Loss	785	140	
	Percent	*Percent*	
Average loss from cultivation	37.2	22.1	

[1] Virgin soil.
[2] Cropped soil.
[3] Increase due to cultivation.

NOTE.—Some of the soils named represent small areas included in areas of other soils.

Soils which contain 2,000 pounds of total nitrogen in each acre of soil about 6 or 7 inches deep produce a good yield of wheat when climatic conditions and other factors are favorable and proper tillage methods are used. However, many cultivated soils in Grant County contain less than 2,000 pounds of total nitrogen to the acre, and the nitrogen which remains in the cropped soil is not so readily

available as that part which has disappeared as a result of losses due to the removal of crops.

Information concerning the chemical composition of soils is important because it frequently explains why some soil types continue to produce good crops, whereas high yields cannot be obtained on other soil types without proper fertilization. Data on the content of plant nutrients in typical soil profiles in Grant County are given in table 6.

TABLE 6.—*Chemical composition of soils in Grant County, Okla.*

UPLAND SOILS

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Organic matter [1]	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Derby fine sandy loam:							
2347	SW¼ sec. 24, T. 26 N., R. 3 W.	0 to 12	6.0	0.043	1.17	0.014	26
2348	do	13 to 36	7.1	.041	.87	.012	34
Derby fine sandy loam, reddish-brown phase:							
2370	SW¼ sec. 8, T. 28 N., R. 8 W.	0 to 6	6.9	.044	1.04	.012	38
2371	do	7 to 14	6.9	.044	.92	.011	30
2372	do	15 to 40	7.2	.012	.23	.011	64
Derby loamy sand:							
2362	NW¼ sec. 6, T. 25 N., R. 5 W.	0 to 6	7.2	.047	1.27	.014	120
2363	do	7 to 14	7.7	.027	.49	.012	44
2364	do	15 to 52	8.0	.007	.17	.009	40
Grant silt loam:							
2357	NW¼ sec. 5, T. 26 N., R. 3 W.	0 to 8	6.5	.106	2.70	.025	4
2358	do	9 to 15	6.3	.087	2.11	.023	2
2359	do	16 to 30	6.2	.057	1.51	.024	1
Grant very fine sandy loam:							
2604	SW¼ sec. 11, T. 25 N., R. 6 W.	0 to 7	6.2	.080	1.57	.017	50
2605	do	8 to 30	7.2	.058	1.41	.019	40
2606	do	31 to 48	8.1	.026	1.62	.013	60
Grant very fine sandy loam, shallow phase:							
2591	SE¼ sec. 6, T. 25 N., R. 6 W.	0 to 10	7.5	.136	2.32	.026	100
2592	do	11 to 24	7.0	.121	1.30	.024	96
2593	do	25 to 30	7.1	.041	.87	.023	128
Oswego silt loam:							
2352	SW¼ sec. 18, T. 27 N., R. 3 W.	0 to 6	6.3	.088	2.30	.026	6
2353	do	7 to 12	7.0	.091	2.20	.023	38
2354	do	13 to 30	8.6	.060	1.54	.029	110
Renfrow silt loam:							
2618	NW¼ sec. 27, T. 27 N., R. 4 W.	0 to 3	6.5	.122	3.10	.018	18
2619	do	4 to 15	6.2	.098	3.35	.017	5
2620	do	16 to 40	7.4	.051	1.47	.007	16
Renfrow silt loam:							
2612	SW¼ sec. 26, T. 28 N., R. 5 W.	0 to 6	6.6	.084	1.55	.014	20
2613	do	7 to 18					
2615	do	19 to 36	7.6	.070	1.16	.007	6
Renfrow clay loam:							
2621	NE¼ sec. 28, T. 25 N., R. 5 W.	0 to 2	8.3	.204	4.02	.034	100
2622	do	3 to 12	8.3	.198	3.97	.039	160
2623	do	13 to 30	8.3	.065	2.47	.031	80
Vernon clay loam, eroded phase:							
2380	NW¼ sec. 21, T. 27 N., R. 4 W.	0 to 5	8.2	.144	3.05	.019	44
2381	do	6 to 18	8.3	.111	2.22	.017	64
2382	do	19 to 36	8.6	.046	1.02	.016	68

TABLE 6.—*Chemical composition of soils in Grant County, Okla.*—Continued

BOTTOM-LAND SOILS

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Organic matter [1]	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Kay silt loam:							
2587	SE¼ sec. 2, T. 26 N., R. 6 W.	0 to 5	6.1	0.245	3.95	0.025	100
2588	do	6 to 24	7.6	.109	1.40	.018	80
2589	do	25 to 50	8.7	.078	.62	.017	96
Kay silty clay loam:							
2384	NE¼ sec. 24, T. 25 N., R. 3 W.	0 to 3	7.2	.117	2.70	.036	190
2385	do	4 to 12	7.6	.081	1.75	.025	160
2386	do	13 to 24	8.4	.071	1.57	.023	140
2387	do	25 to 42	8.7	.054	.88	.028	190
Miller clay loam:							
2609	SE¼ sec. 17, T. 28 N., R. 5 W.	0 to 4	7.4	.171	3.60	.026	100
2610	do	5 to 30	8.5	.049	.99	.024	100
2611	do	31 to 50	8.7	.019	.57	.023	100
Kay silt loam:							
2395	SW¼ sec. 25, T. 26 N., R. 3 W.	0 to 15	6.9	.090	1.95	.024	72
2396	do	16 to 40	8.5	.026	.48	.009	24
Osage silt loam:							
2599	SW¼ sec. 11, T. 27 N., R. 3 W.	0 to 7	7.1	.096	2.67	.028	24
2600	do	8 to 30	7.7	.069	1.77	.017	100
Reinach very fine sandy loam:							
2390	NW¼ sec. 15, T. 25 N., R. 3 W.	0 to 6	7.0	.054	1.30	.033	320
2391	do	7 to 24	7.5	.048	1.17	.028	240
2392	do	25 to 30	7.9	.053	1.12	.027	200
Yahola very fine sandy loam:							
2375	SW¼ sec. 5, T. 25 N., R. 3 W.	0 to 6	7.3	.094	2.19	.033	220
2376	do	7 to 14	8.3	.038	1.32	.032	220
2377	do	15 to 30	8.6	.031	.57	.030	200

[1] Determined by wet combustion method.

A careful study of the acidity of the different soils as determined by pH values will show that none of these samples is more than slightly acid and that many of the surface and subsurface soils are well supplied with limestone. A wide variation occurs in the amount of total nitrogen in the different soils. Soils which contain less than 0.1 percent of total nitrogen are considered to be deficient in this element. The Derby soils are very low in total nitrogen and would respond to nitrogen fertilization. Most of the Renfrow soils are low in total nitrogen, but the samples collected for this study contain more nitrogen than any other upland soil analyzed. The organic-matter content of soils is closely associated with the nitrogen content, and it is difficult to increase the total organic-matter content of a soil when it is being cultivated every year, unless the original amount is very low.

Some attempt should be made to maintain the organic-matter content of soils by adopting a cropping system in which a legume crop is turned under every 4 or 5 years. This is very important on soils which contain less than 2 percent of total organic matter.

The total phosphorus content of all of these soils is low. The average phosphorus content in Oklahoma soils is about 0.03 percent. Only eight of the soils analyzed contained as much phosphorus as occurs in the average Oklahoma soil. The availability of the phos-

phorus in these samples is fairly high, except in samples 2357, 2358, and 2359, which were collected from a typical area of Grant silt loam. This profile is very low in available phosphorus and can be expected to respond to phosphorus fertilization. All soils which contain less than 25 parts per million of readily available phosphorus are deficient in this element when crops like alfalfa or wheat are grown. The presence of available phosphorus in the subsoil may affect the results obtained from fertilization, and this factor should always be considered in studying chemical data.

In order to obtain information concerning the uniformity of soil types and the distribution of nitrogen in the soil profile, samples of soil from six areas of typical Oswego silt loam were obtained and analyzed. The results of these analyses are given in table 7. This soil has developed under a prairie vegetation.

TABLE 7.—*Variations in the nitrogen content of virgin areas of Oswego silt loam in Grant County, Okla.*

Depth of samples	Quantity of nitrogen per 2,000,000 pounds of soil					
	Profile 2871	Profile 2884	Profile 2897	Profile 2921	Profile 2934	Profile 2947
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0 to 6 inches	2,880	2,640	2,100	2,360	2,660	2,880
7 to 12 inches	1,500	2,360	1,830	1,720	1,840	1,940
13 to 18 inches	1,540	2,180	1,720	2,100	1,560	2,460
19 to 24 inches	1,500	1,700	1,400	1,260	1,240	980

The data show that in most cases the nitrogen content of the topmost 6 inches of soil is much higher than in the deeper layers. Where the clay content of the subsurface soil is high and root development is restricted, owing to unfavorable physical conditions, less nitrogen is present in the subsurface layers than in profiles where a deeper development of the roots of prairie grass occurs. Profile 2871 shows the effect of compact subsoils on nitrogen accumulation. The subsurface layers in this profile are much lower in total nitrogen than in profile 2884 which is more porous and in which conditions are more favorable for root development. As the nitrogen content of subsoils is not so important a factor in crop production as the amount of nitrogen in the surface soils, as surface soils decrease in nitrogen content, crop yields decline, and this is a common condition on many farms of Grant County.

Although the total phosphorus content of the soils of this county is not high, the greater part of the soils contains enough available phosphorus that plant growth in most places is not restricted on account of a lack of this particular element in an available form. Of 78 samples examined, 40 were very high in readily available phosphorus soluble in a 1-to-10 extract of fifth-normal sulphuric acid, 26 were high, 4 were medium, and 8 were low. All but 8 of the samples of surface soil studied contained enough phosphorus that very little response would be obtained from phosphate fertilizers applied to small-grain crops, sweetclover, or corn. Soils low in readily available phosphorus will respond to phosphorus fertilization when wheat and alfalfa are grown, and it is possible that crop yields on soils low in phosphate will not be appreciably increased by

the addition of organic matter, unless a phosphate fertilizer also is used. Information concerning phosphorus availability in soils and methods for taking soil samples for analysis can be obtained by writing to the Oklahoma Agricultural Experiment Station, Stillwater, Okla.

A study of the degree of acidity present in the soils indicates that wide variations occur among the different soil types. Data on the reaction of 110 samples of soil are as follows: Basic, 18; neutral, 29; slight acidity, 30; slight+acidity, 12; medium acidity, 14; medium +acidity, 4; and strong acidity, 3.

In most cases soils which are basic, neutral, or slightly acid do not respond to applications of lime for ordinary field crops. This is especially true when the subsoils contain a good supply of lime. Soils which range from medium to strongly acid should receive an application of ground limestone, in order that conditions may be most favorable for plant development. Many of the nearly level upland soils are acid in the surface soil but contain lime at a depth ranging from 18 to 24 inches. Sandy soils which absorb moisture readily are in general more acid than finer textured soils which occur in rolling areas. Alluvial soils are not so acid as the older sandy soils of the upland. Although the problem of soil acidity is not very important on the average farm, there are many farms where an application of lime would improve the yield of sweetclover and make it possible to hold stands of alfalfa over a longer period.

Many soils are nearly level, and the subsoils beneath these areas are rather impervious to water. The construction of terraces with a slight fall from these areas will aid materially in removing excess water which may frequently interfere with crop production, and where cultivated crops are grown they may be planted parallel to the terrace ridges, in order to facilitate drainage. On the more rolling areas terraces will reduce erosion and, consequently, will assist in maintaining the fertility of the soil as well as conserving water for plants. Most of the erosion occurring in this county is sheet erosion, and many farmers do not appreciate the importance of controlling the loss of plant nutrients which occurs when soil is carried away by run-off water. Although wheat farming reduces the quantity of soil lost, as compared with land cropped continually to row crops, there are many areas where the use of terraces will not only conserve moisture but will prevent the loss of valuable plant nutrients.

Sweetclover is one of the best crops to use in a cropping system, in order to add nitrogen to the soil. More than 10,000 acres are annually devoted to sweetclover. The total number of acres in the county, however, is more than 60 times this figure, which means that if legumes should continue to be planted at the present rate on all soils it would be more than 40 years before all of the land was planted to a leguminous crop. In order to maintain the nitrogen content of the soils, leguminous crops should be grown on the land every fourth or fifth year, and this would require a total acreage of 150,000 acres of legumes instead of less than 15,000 acres which are now devoted to such crops.

Since wheat is one of the major crops, practically all cropping systems will be centered around its production. The three most

important crops to be grown in a wheat rotation are alfalfa, sweet-clover, or a winter legume, such as Austrian winter peas or hairy vetch. Satisfactory crop yields will be produced on most of the soils in this county for many years without any further addition of plant nutrients, such as lime or phosphate fertilizers, if leguminous crops are grown in rotation and large amounts of organic matter are returned to the soil every 4 or 5 years. On the soils of the first bottoms and terraces along the larger streams, which are not poorly drained, alfalfa can be grown in rotation with corn and small grains, and this is a very satisfactory system to use in maintaining the organic matter and nitrogen content of the soil. The chief difficulty with alfalfa is that the fields are not changed frequently, and a maximum utilization of the nitrogen-fixing capacity of this plant is not obtained. Under average conditions, alfalfa should not remain on the land longer than 4 or 5 years. By constantly changing the alfalfa from one field to another, crop yields should be maintained at a high level without any further treatment, as far as the addition of nitrogen is concerned.

SUMMARY

Grant County lies in the north-central part of Oklahoma along the Kansas State line. It has an area of 994 square miles, or 636,160 acres. The surface relief is level or gently undulating, and drainage is well established. The county is drained by Salt Fork Arkansas River and its tributaries.

The population is uniformly distributed. The total population in 1930 was 14,150, all classed as rural.

Transportation facilities are good. Roads leading to local and distant markets are kept in good repair.

The mean annual rainfall is 29.52 inches, most of which occurs during the growing season. The mean annual temperature is 58.3° F. Hot winds frequently blow from the south during August.

Wheat is the predominant crop. Most farmers report from 160 to 200 acres in wheat, 20 acres in corn or kafir, from 20 to 30 acres in oats, and from 5 to 10 acres in alfalfa.

Very few farmers raise hogs. A few chickens are raised on every farm. Most of the farmers have 2 or 3 cows to supply the family with milk and butter. Raising of livestock on an extensive scale is practiced on a few farms that have soils particularly well adapted to the growing of hay and row crops, including corn.

Some of the soils in the valley of Salt Fork Arkansas River are well adapted to growing watermelons, and many carloads of melons are shipped from that section every year.

The soils of the Reinach, Osage, and Yahola series are the best corn and alfalfa soils, and as a result most of the farms developed on these soils are devoted almost entirely to the raising and feeding of hogs and cattle.

Twenty soil types and seven phases of types were identified in the survey, and they are included in the Oswego, Renfrow, Grant, Vernon, Derby, Reinach, Yahola, Osage, Miller, Kay, and Pond Creek soil series.

The Oswego soils are characterized by gray or dark grayish-brown surface soils underlain by dark-brown friable subsoils which, in turn,

are underlain by a dark-brown claypan at a depth of 15 inches. Wheat is the principal crop grown on these soils.

The Renfrow soils have brown surface soils and brown or slightly reddish-brown friable subsoils that extend to a depth of 20 inches before a claypan horizon is reached.

The Grant soils have brown surface soils and brown or dark reddish-brown subsoils which continue downward into more friable material as depth increases.

The Vernon soils have chocolate-brown or red clay surface soils, passing within a few inches into red plastic clay subsoils. Wheat is the most productive grain crop that can be grown on these soils. On account of the high lime content of the surface soil, sweetclover is successfully grown.

The Derby soils embrace the most sandy parts of the county. They have brownish-gray sandy surface soils and brown or reddish-brown friable sandy subsoils. The more sandy soils are well adapted to growing watermelons, especially in the eastern part. In the western part, row crops are the principal crops grown. The soil mapped as a reddish-brown phase of Derby fine sandy loam is heavier in texture than the typical soil and is considered a good soil for wheat and row crops.

The Reinach soils occur on terraces and first bottoms. They have brown or light-brown friable surface soils and brown friable subsoils. They are very highly prized by the farmers.

The Yahola soils occupy second bottoms and are subject to overflow after heavy rainfall. They are equally as productive as the Reinach soils. The reddish-brown friable surface soil is underlain by a reddish-brown friable subsoil which in many places passes downward into more sandy material at a depth ranging from 30 to 36 inches. The surface soil is much more red than that of the Reinach soils.

The Osage soils have dark-brown surface soils which are underlain by darker colored subsoils at a depth of about 14 inches. They are first-bottom soils and are subject to overflow during very rainy seasons. They are very productive. They have darker surface soils than the Reinach soils.

The Miller soils have chocolate-brown or reddish-brown surface soils underlain at a depth of 6 inches by reddish-brown plastic clay subsoils. They occupy small stream valleys.

The Kay soils occur on low terraces, where the surface relief is flat and level and drainage is slightly restricted. They have grayish-brown or brown surface soils that are underlain, at a depth of 8 or 10 inches, by dark grayish-brown clay subsoils. These soils have darker colored surface soils than the Reinach soils. Wheat is the principal crop grown.

The Pond Creek soils have dark-brown slightly granular surface soils and grayish-brown subsoils. They occur on level, flat uplands.

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Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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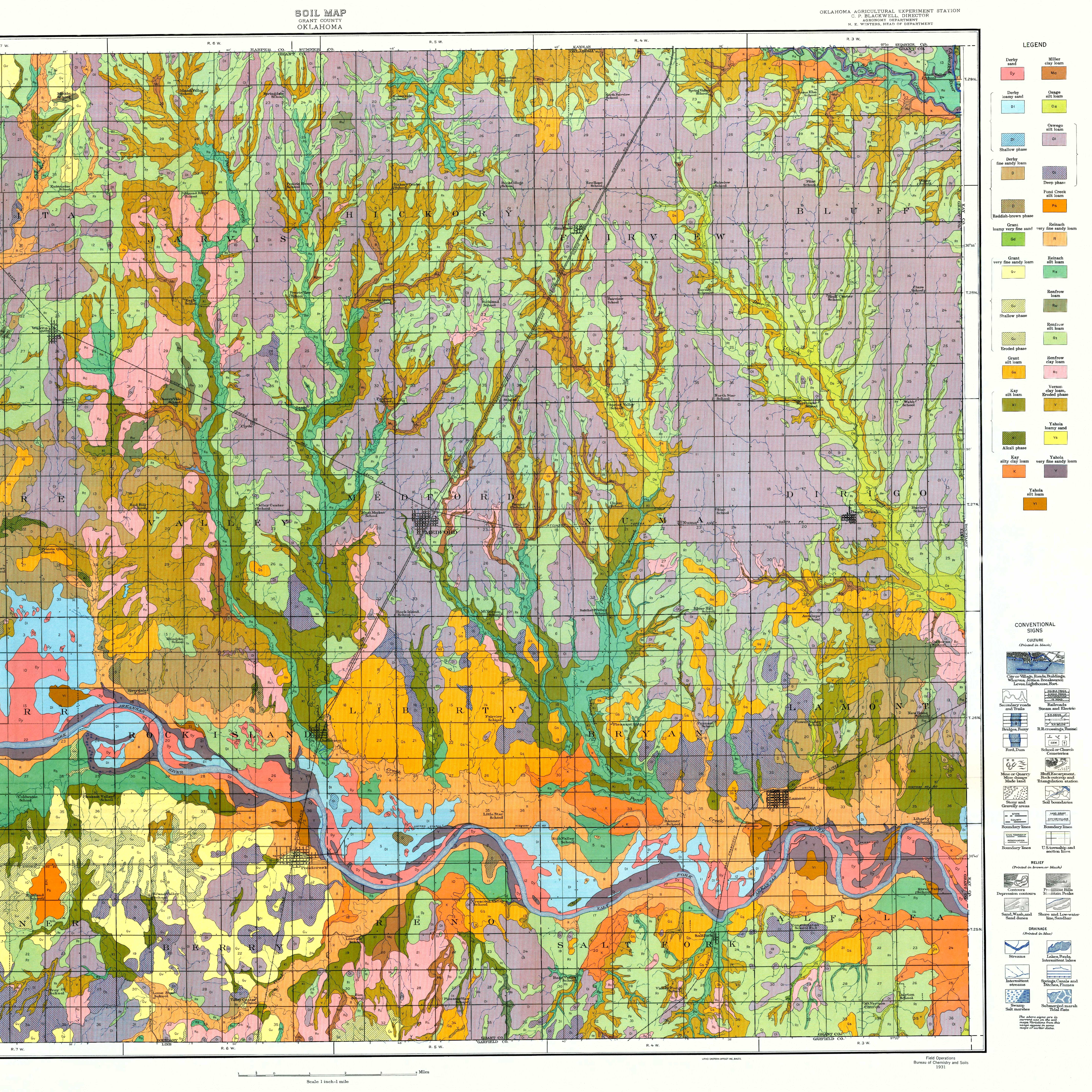
SOIL MAP
GRANT COUNTY
OKLAHOMA
OKLAHOMA AGRICULTURAL EXPERIMENT STATION
C. P. BLACKWELL, DIRECTOR
AGRONOMY DEPARTMENT
N. E. WINTERS, HEAD OF DEPARTMENT
LEGEND
Derby sand Dy
Miller clay loam Mc
Derby loamy sand Dl
Osage silt loam Os
Shallow phase
Oswego silt loam Ol
Derby fine sandy loam D
Deep phase
Pond Creek silt loam Ps
Reddish-brown phase
Grant loamy very fine sand Gd
Reinach very fine sandy loam R
Grant very fine sandy loam Gv
Reinach silt loam Rs
Renfrow loam Rw
Shallow phase
Renfrow silt loam Rt
Eroded phase
Grant silt loam Gs
Renfrow clay loam Rc
Kay silt loam Kl
Vernon clay loam, Eroded phase V
Yahola loamy sand Ys
Alkali phase
Kay silty clay loam K
Yahola very fine sandy loam Y
Yahola silt loam Yl
CONVENTIONAL SIGNS
CULTURE
(Printed in black)
City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R.R.crossings, Tunnel
Ford, Dam
School or Church Cemeteries
Mine or Quarry Mine dumps Made land
Bluff, Escarpment, Rock outcrop and Triangulation station
Stony and Gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U.S. township and section lines
RELIEF
(Printed in brown or black)
Contours Depression contours
Prominent Hills Mountain Peaks
Sand, Wash, and Sand dunes
Shore and Low-water line, Sandbar
DRAINAGE
(Printed in blue)
Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Swamp Salt marshes
Submerged marsh Tidal flats
The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.
JARVIS
HICKORY
FAIRVIEW
BLUFF
MEDFORD
NUMA
DIRIGO
VALLEY
LIBERTY
BRYAN
LAMONT
ROCK ISLAND
RENO
SALT FORK
ALFALFA
MEDFORD
KANSAS
OKLAHOMA
HARPER CO.
SUMNER CO.
GRANT CO.
GARFIELD CO.
KAY CO.
R. 6 W.
R. 5 W.
R. 4 W.
R. 3 W.
T. 29 N.
T. 28 N.
T. 27 N.
T. 26 N.
T. 25 N.
Scale 1 inch=1 mile
Miles
Field Operations
Bureau of Chemistry and Soils
1931